CHANGES OF ELEMENT CONTENT OF SOIL ON APPLICATION OF BIOGAS FERMENTATION SLUDGE

Imre Vágó[1], Marianna Makádi[2], Imre Czinkota[3], János Kátai[1], László Tolner[3]




University of Debrecen

[1]*Department of Agricultural Chemistry and Soil Science, H-4032 Debrecen, Böszörményi út 138., vago@agr.unideb.hu*

[2]*Research Centre , H-4400 Nyíregyháza, Westsik Vilmos Str. 4-6.*

Szent István University

[3]*Department of Soil Science and Agricultural Chemistry, H-2103 Gödöllő, Páter K. Str. 1*

INTRODUCTION

In the reduction of the for the environment potentially problematic CO_2-emission the even wide practical use of renewable energy based on agricultural and food processing by-products plays an important role. Besides biomass power plants another important method to gain and use renewable energy is biogas-production based on the reductive fermentation of agricultural by-products with high organic matter content. These procedures have a same attribute insofar as the placement of attendant products (in case of biomass power plants the high amount of ash, while in case of biogas production the fermentation residues) is rather difficult. As the residues of both procedures contain a significant amount of plant nutrients, their possible use in plant production is considerable.

MATERIAL AND METHODS

The effect of fermentation residue liquid on acidic (pH-KCl: 4.89) sandy soil within a field experiment at Nyírbátor, Hungary, in 2007, was studied.

Characteristics of fermentation residue		
pH(KCl): 8.025	Density: 1.026 t m^{-3}	Dry matter content: 1.18 %
Total N-content: 0.376 %	Total P-content: 0.28 g kg^{-1}	Total K-content: 0.74 g kg^{-1}
Mg-content: 32.7 mg kg^{-1}	Na-content: 272.5 mg kg^{-1}	

The fermentation residue was applied in 5 and 10 dm^3 m^{-2} dosages by a liquid manure spreader. The randomized experimental plots were set up in four replications with soybean (*Glycine max L.* Merr. 'Otília') as a test plant. The yield of soybean was harvested in October, and then soil samples were taken from the upper 0-20 cm layer of the experimental plots.

The soil samples were dried, grinded, extracted with 0.01 M dm^{-3} $CaCl_2$ solution, and filtered. The extracted element contents were measured by ICP OES method. The results were evaluated by a single factor ANOVA using the computer program developed by Tolner.

RESULTS

The effects of application of biogas fermentation residue on the 0.01 M dm^{-3} $CaCl_2$ extractable element content of soil (mg kg^{-1}) are shown in Table 1.

The application of fermentation residue liquid didn't affect significantly the extractable Al, B, Be, Cd, Co, La, Li, Ni and Sr amount of the soil under soybean.

It is reassuring that the concentration of the measured heavy metals (Cd, Co, La, Ni, Sr) didn't change in the soil solutions. This statement is also true in case of some other metals (Be, Li).

The P and K content increased at a significance level P = 5.0 %, while the increment of sulphur was significant at P = 1.0 % level. It is especially conspicuous that the soluble P-content of soil was five times higher (!), but the potassium and the sulphur content were also more than one and a half times higher than in the control treatment. The increment of the P-, K- and S-resource of the soil is definitely due to the application of fermentation residue liquid.

The amount of manganese increased in a close significant (P = 0.1 %) extent, by almost 40 %. In contrast the increment of the copper content was lower and only at P = 10 % level significant.

It is unfavourable that the sodium content of the soil increased to almost twice higher level (at P = 5.0 % significance). The increment of the sodium content is not only for the plants harmful, but – in a longer period – it can affect the soil parameters in a negative way as well.

Table 1.
The effect of application of biogas fermentation sludge on the 0.01 M dm^{-3} $CaCl_2$ extractable element content of soil (mg kg^{-1})

Element	Control	5 dm^3 m^{-2} residue	10 dm^3 m^{-2} residue	F value, significance	LSD 5%
Al	2.80	2.53	1.50	1.32 n.s.	
B	0.33	0.45	0.50	2.92 n.s.	
Be	4.54	4.50	3.87	0.58 n.s.	
Cd	0.063	0.067	0.0545	1.00 n.s.	
Co	0.064	0.071	0.057	1.18 n.s.	
Cu	0.089	0.112	0.118	5.18+	0.026
K	44.43	65.3	72.5	9.91*	18.16
La	0.175	0.172	0.173	1.92 n.s.	
Li	0.148	0.152	0.160	0.60 n.s.	
Mg	46.9	54.1	65.7	45.64**	5.49
Mn	25.5	35.1	35.5	247.5***	1.41
Na	16.6	31.5	38.0	15.7*	10.92
Ni	0.50	0.52	0.35	0.81 n.s.	
P	0.77	1.94	3.62	8.93*	1.88
S	5.92	8.18	9.90	18.79**	1.85
Sc	0.025	0.027	0.029	94.72***	0.0008
Si	0.32	0.35	0.45	5.08+	0.12
Sr	8.56	8.60	8.62	0.01 n.s.	
Zn	1.40	0.98	0.62	10.92*	0.46

CONCLUSIONS

The result of our experiment on an acidic sandy – with low buffering capacity, therefore to the external negative effects sensitive – soil show, the use of the liquid by-product of biogas fermentation has favourable results in the plant nutrition: the amount of the majority of extractable macro- meso- and micro-elements increased in the soil. We could not reveal any accumulation of toxic elements. In our opinion the fermentation residue is adaptable for fertilization. It has to be noted that the sodium content of the soil increased that confirms the need of adequate caution in the application.